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Planning sunlight cities

New York

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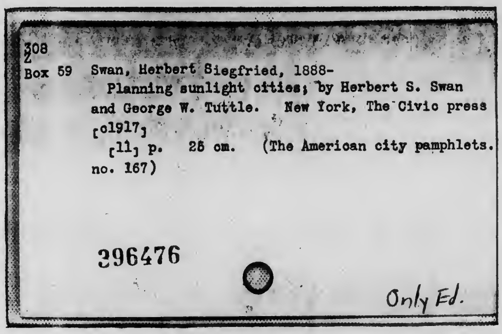

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PLANNING SUNLIGHT CITIES

BY

HERBERT S. SWAN

AND

GEORGE W. TUTTLE

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Planning Sunlight Cities*

By
Herbert S. Swan
and
George W. Tuttle

SUNLIGHT cities must be planned from the start. The width and arrangement of streets, the length and breadth of the lot, the type, height and use of building, the least dimension and orientation of courts and yards, the latitude and the topography of the site—all of these have to be considered in laying out a sunlight town. If each of these factors is given its proper weight when the town is first planned, a maximum of sunlight will be assured every home and work-place in the community, not to mention the streets, courts and yards; ignored, then no amount of replanning can ever completely rectify the mistake.

Two things are essential to a sunlight plan—a street plan and a building plan. Each of these has to be conceived and perfected in harmony with the other as one unit. They are reciprocal parts of the sunlight plan, and they therefore stand or fall together. It is impossible to give proper consideration to one without at the same time considering the demands of the other. Any other method of treatment is disastrous to the sunlight plan.

Shadows Cast by Sky-Scrapers

The street plan and the building plan have been so poorly coördinated in Manhattan, for instance, that it is safe to say that a preponderating majority of the rooms in the existing shops, factories, offices and apartments of the borough receive no direct sunshine on the shortest day in the year.

This is no less true of the residential sections than of the business sections. But the situation in the downtown financial district illustrates this condition most dramatically. There the shadows of different skyscrapers, at noon on December 21, envelop large areas. The Adams Express Building, which is 424 feet high, casts a shadow 875 feet in length; the Equitable Building, which is 493 feet high, one 1,018 feet in length; the Singer Tower, which is 546 feet high, one 1,127 feet in length; and the Woolworth Tower, which is 791 feet high, one 1,635 feet in length.

The effect of skyscrapers casting shadows from a sixth to a third of a mile in length on surrounding property is well illustrated in the case of the Equitable Building. Its shadow, which at noon on the shortest day in the year is about one-fifth of a mile in length, completely envelops an area of 7.59 acres. The ground area of the Equitable Building is only 1.14 acres.

The shadow cuts off all sunshine from the Broadway façade of the United States Realty Building, which is twenty-one stories high. The New York Title & Mortgage Company Building, fourteen stories high, and the Washington Life Insurance Building, nineteen stories high, are both completely shaded. The south side of the Singer Tower is shaded to a height of twenty-seven stories. The nearest part of the City Investing Building, 400 feet away, is in shadow for twenty-four of its twenty-six stories. Even part of the New York Telephone Building north of Cortlandt Street is shadowed by the Equitable Building. For almost a fifth of a mile this giant skyscraper casts its shadow.

Cedar Street, the street immediately north of the Equitable Building, has an average width of 34 feet between Broadway and Nassau Street. The height of the Equitable Building is 14½ times the width of this street. On a north-and-south street of this width in New York, uniformly improved on both sides with buildings having a height equal to that of the Equitable Building, only 9.31 per cent of the windows would receive any direct sunshine at noon on the shortest day in the year. On such streets only the windows nearest the top for a distance equal to 1.35 times the width of the street would receive direct sunshine at noon on December 21 at New York (taking 40° north as the latitude), assuming the windows to be set in walls 14 inches thick. The windows in the thirty-four stories nearest the ground would receive absolutely no direct sunlight. Direct sunshine would only enter those windows in the four stories nearest the top. Not a single window within 447 feet of the street level would receive a ray of direct sunshine!

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High buildings should be erected on wide streets and large open spaces; narrow streets and small open spaces should be improved with low buildings. But altho the height of a building should be proportionate to the width of the open space on each side from which it receives its sunlight, it does not at all follow that this proportion should be the same on all sides of the open space nor at all latitudes.

Effect of Latitude

The farther north a city is situated, the greater is its need for a sunlight plan. Sunlight is a natural resource to be conserved and economized like any other gift of nature. There are places on the earth's surface where the supply of sunshine is so constant that there is probably very little necessity to impose any restrictions upon its use —there is enough for all. But in contrast with these there are other places, and these places contain the great bulk of the urban population thruout the world, which possess such a fluctuating supply of sunshine that its use must be subjected to the strictest safeguards or the supply will be squandered to no purpose.

The distance from the equator is of paramount importance in planning a sunlight city. In the first place, the length of the shortest day diminishes as the latitude increases. The sunlight period at Key West on December 21 is only seven-eighths as long as that at the equator. At Winnipeg it is only two-thirds as long as that at the equator. In the second place, the angle of the sun's altitude diminishes with increased distance from the equator. At Winnipeg the altitude of the sun at noon at the winter solstice is only 16.6°. At the equator it is 66.6°.

The effect of this difference in altitude in the sunlighting of streets and buildings at different latitudes is apparent. With each additional degree of latitude from the equator, to obtain the same amount of sunlight, assuming that it could be obtained, the height of building would have to be decreased or the width of street increased.

To illustrate: Suppose that the height of buildings on the south side of east-and-west streets of a given width were limited on the principle that the sun's rays would shine for just one moment at the curb level on the opposite side of the street. On this basis buildings at Winnipeg could only be three-tenths the street width in height, while at the equator they could be 2.31 times the street width in height. In lieu of varying the height of the buildings, the above principle could be observed by varying the street width with the latitude. In that event the width of the street at the equator need be only 0.43 times the height of the building, while at Winnipeg it would have to be 3.33 times the height of the building. The street width required at Winnipeg would be 7.7 times that required at the equator.

Orientation of Streets

The orientation of streets counts for quite as much as the latitude of the locality and the height of buildings in planning a sunlight town. A little sunlight engineering in city planning can to a large extent overcome the two natural disadvantages of a northern latitude in winter—the shortness of the day and the low altitude of the sun. The fact that a sunlight plan can be designed for Winnipeg which will give the curb level in front of every house more sunshine than a non-sunlight plan will at

TABLE I. SUNSHINE PERIOD AT GROUND LEVEL OF STREET FACADE.

For different latitudes and for each side of streets oriented in different directions, and improved with buildings of different heights.
Winter solstice.

Orientation of Street.

(Side of street)

(Time in hours and minutes)

Height of building in terms of street width	South		15° W.		30° W.		45° W.		60° W.		75° W.		West	
	e. s.	w. s.	e. s.	w. s.	e. s.	w. s.	s. s.	n. s.	s. s.	n. s.	s. s.	n. s.	s. s.	n. s.
	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.	h.m.
25° North Latitude.														
½	3 24	3 24	2 58	3 54	2 24	4 38	1 40	5 46	0 30	7 25	....	8 04	....	8 08
1	2 18	2 18	1 06	2 32	1 45	3 00	1 18	3 39	0 21	4 39	....	0 34	....	....
1½	1 42	1 42	1 38	1 43	1 22	2 08	1 03	2 27	0 18	2 38	....	....	....	....
2	1 23	1 23	1 19	1 30	1 06	1 36	0 50	2 00	0 16	1 30	....	....	....	....
2½	1 04	1 04	0 62	1 11	0 53	1 20	0 48	1 23	0 14	1 08	....	....	....	....
3	0 56	0 56	0 52	0 59	0 51	1 01	0 42	1 04	0 13	0 48	....	....	....	....
4	0 45	0 45	0 44	0 46	0 43	0 49	0 38	0 54	0 12	0 38	....	....	....	....
5	0 39	0 39	0 38	0 40	0 38	0 43	0 33	0 43	0 10	0 29	....	....	....	....
6	0 35	0 35	0 34	0 37	0 35	0 39	0 31	0 40	0 09	0 24	....	....	....	....
Deduct for windows	41	41	46	41	56	47	1 22	59	Entire time	1 28	....	....	....	....
30° North Latitude														
½	3 10	3 10	2 41	3 44	2 07	4 24	1 24	5 31	0 18	7 07	....	6 54	....	6 28
1	2 07	2 07	1 51	2 24	1 28	2 45	1 20	3 16	0 12	3 46	....	....	....	....
1½	1 34	1 34	1 24	1 41	1 10	1 52	0 50	2 05	0 10	1 37	....	....	....	....
2	1 16	1 16	1 06	1 18	0 57	1 26	0 43	1 29	0 08	0 48	....	....	....	....
2½	0 58	0 58	0 55	1 03	0 51	1 07	0 37	1 05	0 06	0 35	....	....	....	....
3	0 50	0 50	0 48	0 52	0 45	0 54	0 35	0 54	0 06	0 22	....	....	....	....
4	0 42	0 42	0 40	0 43	0 38	0 45	0 31	0 45	0 06	0 19	....	....	....	....
5	0 37	0 37	0 35	0 38	0 33	0 40	0 26	0 38	0 05	0 13	....	....	....	....
6	0 33	0 33	0 32	0 33	0 31	0 37	0 25	0 34	0 05	0 12	....	....	....	....
Deduct for windows	43	43	49	43	57	49	1 20	59	Entire time	1 23	....	....	....	....
35° North Latitude.														
½	2 52	2 52	2 25	3 30	1 51	4 07	1 08	5 04	0 06	6 35	....	5 36	....	4 50
1	1 52	1 52	1 38	2 08	1 20	2 28	0 50	2 44	0 05	2 23	....	....	....	....
1½	1 23	1 23	1 11	1 32	1 00	1 40	0 41	1 40	0 04	0 30	....	....	....	....
2	1 10	1 10	0 57	1 10	0 47	1 13	0 35	1 06	0 02	0 10	....	....	....	....
2½	0 53	0 53	0 45	0 55	0 43	0 55	0 30	0 50	....	0 07	....	....	....	....
3	0 46	0 46	0 43	0 47	0 38	0 47	0 28	0 44	....	....	....	....	....	....
4	0 38	0 38	0 36	0 39	0 32	0 40	0 24	0 35	....	....	....	....	....	....
5	0 34	0 34	0 32	0 35	0 31	0 34	0 19	0 31	....	....	....	....	....	....
6	0 30	0 30	0 29	0 31	0 27	0 30	0 17	0 26	....	....	....	....	....	....
Deduct for windows	45	45	50	46	58	51	Entire time	60	Entire time	1 16	....	....	....	....
40° North Latitude.														
½	2 37	2 37	2 04	3 07	1 33	3 45	0 50	4 32	....	5 10	....	3 06	....	....
1	1 40	1 40	1 25	1 52	1 04	2 04	0 38	2 04	....	....	....	....	....	....
1½	1 10	1 10	1 00	1 20	0 50	1 20	0 28	1 08	....	....	....	....	....	....
2	1 00	1 00	0 50	0 59	0 44	1 00	0 25	0 46	....	....	....	....	....	....
2½	0 47	0 47	0 41	0 48	0 35	0 47	0 23	0 35	....	....	....	....	....	....
3	0 41	0 41	0 37	0 42	0 32	0 37	0 20	0 31	....	....	....	....	....	....
4	0 34	0 34	0 31	0 34	0 27	0 34	0 18	0 25	....	....	....	....	....	....
5	0 30	0 30	0 29	0 31	0 23	0 30	0 14	0 21	....	....	....	....	....	....
6	0 27	0 27	0 24	0 27	0 22	0 26	0 14	0 19	....	....	....	....	....	....
Deduct for windows	48	48	52	48	58	53	Entire time	60	....	59	....	....	....	....
45° North Latitude.														
½	2 18	2 18	1 48	2 44	1 15	3 13	0 35	3 45	....	2 50	....	....	....	....
1	1 24	1 24	1 10	1 34	0 48	1 40	0 24	1 24	....	....	....	....	....	....
1½	0 58	0 58	0 50	1 03	0 38	1 02	0 21	0 48	....	....	....	....	....	....
2	0 49	0 49	0 43	0 48	0 32	0 46	0 16	0 32	....	....	....	....	....	....
2½	0 38	0 38	0 33	0 40	0 25	0 37	0 13	0 24	....	....	....	....	....	....
3	0 34	0 34	0 31	0 35	0 24	0 32	0 13	0 20	....	....	....	....	....	....
4	0 28	0 28	0 27	0 29	0 21	0 27	0 12	0 19	....	....	....	....	....	....
5	0 25	0 25	0 22	0 25	0 18	0 23	0 09	0 14	....	....	....	....	....	....
6	0 22	0 22	0 21	0 23	0 17	0 20	0 08	0 12	....	....	....	....	....	....
Deduct for windows	50	50	54	50	59	54	Entire time	1 01	....	....	....	....	....	....
50° North Latitude.														
½	1 52	1 52	1 27	2 14	0 55	2 36	0 22	2 39	....	....	....	....	....	....
1	1 06	1 06	0 52	1 13	0 36	1 10	0 15	0 36	....	....	....	....	....	....
1½	0 47	0 47	0 38	0 47	0 28	0 50	0 10	0 21	....	....	....	....	....	....
2	0 41	0 41	0 32	0 38	0 23	0 40	0 08	0 15	....	....	....	....	....	....
2½	0 30	0 30	0 27	0 32	0 20	0 30	0 07	0 13	....	....	....	....	....	....
3	0 27	0 27	0 24	0 29	0 17	0 23	0 06	0 10	....	....	....	....	....	....
4	0 22	0 22	0 20	0 25	0 15	0 19	0 06	0 08	....	....	....	....	....	....
5	0 20	0 20	0 17	0 22	0 13	0 17	0 04	0 07	....	....	....	....	....	....
6	0 18	0 18	0 16	0 19	0 12	0 15	0 04	0 06	....	....	....	....	....	....
Deduct for windows	51	51	55	53	Entire time	55	Entire time	1 01	....	....	....	....	....	....

TABLE II.—NUMBER OF DAYS CURB LEVEL IS IN SHADOW ON EAST AND WEST STREETS.

Height of building in terms of street width	North Latitude 25°	30°	35°	40°	45°	50°
	Number of Days					
½	0	0	0	0	73	108
1	61	98	127	153	181	182
1½	135	161	182	182	182	182
2	172	182	182	182	182	182
2½ and over	182	182	182	182	182	182

Key West, demonstrates this conclusively. Indeed, astonishing as it may seem, the very same buildings which, if arranged along the lines of the non-sunlight plan at Key West, would rob the pavement in front of every house of all sunlight, can be arranged at Winnipeg in such a manner as to give the street in front of every house more than an hour of sunshine. In each case the buildings would be in rows and once the width of the street in height, but in the southern city they would all front on east-and-west streets, while in the northern city they would all front on north-and-south streets.

Table I shows the sunshine period at the ground level of the street façade. This is given for different latitudes and for each side of streets oriented in different directions and improved with buildings of different heights. The table also shows the sunlight period at any distance below the top of the building given in the left-hand column. The times have been worked out for every five degrees from 25° north latitude to 50° north latitude, inclusive. These latitudes include all of the United States and a large portion of Canada. Cities near or at the different latitudes are: 25°, Key West; 30°, New Orleans and Houston; 35°, Memphis and Albuquerque; 40°, Philadelphia, Indianapolis and Denver; 45°, Minneapolis and Portland, Ore., and 50°, Winnipeg. The streets used include those oriented north and south and those oriented every 15 degrees west of south to and including east-and-west streets. Data for streets oriented east of south are identically the same as for streets oriented west of south, except that the sides of the streets are reversed. The height used is in each instance a multiple of the street width, this multiple varying from one-half times the street width to six times the street width, the higher multiple being worked out primarily for alleys and rear yards. Both streets and alleys are assumed to be open at either end for an indefinite distance.

The sunshine period given in this table is that received by the street façade at a given distance below the top of the buildings on the opposite side of the street. The amount entering a window at any particular height is, of course, less than that falling on the façade. The number of minutes of sunshine received by the façade cut off from entering a standard window by an 8-inch wall is indicated in the last line of the table for each latitude. The standard window considered is one with a glass surface 32 inches wide and 61½ inches high, the opening between the stop beads being 36 by 66 inches. For a wall thicker than 8 inches the amount of sunshine cut off from the window would be greater than that stated in the table.

The number of days that the north façade of an east-and-west street is shaded at the street level depends upon the latitude and the height of the buildings. Buildings once the street width in height at Key West cut off all sunlight for 61 days in the year; at Winnipeg for 182 days. In very few cities of the United States does the sun penetrate down to the sidewalks on east-and-west streets in the skyscraper district for more than half the year. The alleys and yards back of such buildings are often so narrow as to shut out all the noonday sunlight thruout the year at the bottom level.

Table II shows the number of days in the year that the north façade at the curb level of east-and-west streets situated at different latitudes and improved with buildings of different heights receives absolutely no sunlight.

The street system of Manhattan (40° 45′ N. Lat.) is an excellent illustration of what a sunlight plan should not be. The blocks, in brief, are 200 feet wide and as much as 920 feet long, the narrow dimension being oriented 28° 30′ west of south and the long dimension 61° 30′ east of south. This arrangement is most unsatisfactory. Where a block of the above dimensions is uniformly improved with buildings once the street width in height, a height which allows the construction of a six-story tenement house, only the two ends near the avenues receive any sunlight at all at the curb level on the shortest day in the year. In other words, the tenement houses fronting on the streets embracing 82 per cent of the total block frontage receive no sunlight at the ground except near the ends of the block, due to the avenues. If the long side of the blocks paralleled the avenues instead of the streets in Manhattan, the situation would be very much improved. But 18 per cent of the frontage would then be in shadow at the curb level. Sunlight homes and sunlight streets would then be given to an additional 64 per cent of the population. The effect of this increase in sunlight on individual initiative and vigor, on public health, on sanitation, on the spread of contagious disease, on snow removal and on traffic conditions, can be imagined.

Minimum Standards of Sunlight

In a sunlight plan, minimum standards of sunlight will be established for the interior of rooms and for the curb level of every street and yard as on the shortest day of the year. This standard of sunlight may be fifteen minutes, a half-hour, an hour, or two hours, according to the requirements of the particular locality, but in each case the height of building, whatever it may be, will be regulated with reference to the width of the street and yard space in such a manner as to secure this minimum amount of sunlight.

Either the height of building, or the width of streets and yards, will at any given latitude be made to vary according to orientation in order to meet the requirements of this standard. At Philadelphia, for example, to obtain fifteen minutes of sunlight on either side of a north-and-south street at the curb level, the height of building may be 7.5 times the street width. But to obtain the same amount of sunlight on the north side of an east-and-west street the height of the buildings on the south side may not exceed one-half the street width.

Table III shows the uniform height to which buildings fronting on streets of different orientations may be erected at different latitudes in order to obtain given periods of sunlight at the curb level or at the same distance from the top of the building on the opposite side of the street on the shortest day in the year. This height limit has been calculated by fifteen-minute periods from a quarter of an hour to two hours of sunlight. The maximum height to which buildings may be erected so as to allow a given minimum period of sunlight at the ground on the opposite side of the street is represented as a coefficient or multiple of the street width. To ascertain the height limit permitting the desired amount of sunlight, it is, therefore, only necessary to multiply the street width by the coefficient in the table. To ascertain the street width required to furnish a building of a given height a minimum quantity of sunlight at the curb level, it is only necessary to divide the height of the building by the appropriate coefficient for the period of sunlight required, as given in Table III. The quotient will be the allowable width of street. The height of building in this table is in each case given to the nearest tenth of the street width. This fact explains apparent discrepancies between Table I and Table III.

Arrangement of Buildings

In the winter season no sunlight can, of course, be obtained on the south side of an east-and-west street. No adjustment in the height of buildings or in the street width can sun-light rooms having a northerly exposure. The remedy in such a case would be to require the rooms to have windows exposed toward one of the other three points of the compass. This can readily be done in detached houses, but it is very difficult in attached houses. This condition suggests the advisability of reserving east-and-west streets for detached houses. North-and-south streets, on the other hand, may be developed with either attached or detached houses.

Buildings should generally be arranged in such a manner that the narrow dimension is oriented east and west and the long dimension north and south, so that the greater length may receive sunlight on both faces.

Compliance with these principles would favor streets of a north-and-south orientation for attached houses. In the case of detached houses the orientation of the street is not so important, an east-and-west street in some respects being superior to a north-and-south street. For a private-house district an east-and-west street has this decided advantage—the narrow dimension of the lot may front the street; on a north-and-south street the length of the lot would have to front the street. The requisite sunlight for detached houses of a villa type can, in other words, be purchased more cheaply on an east-and-west street than on a north-and-south street.

TABLE III. MAXIMUM HEIGHT LIMITS FOR DIFFERENT PERIODS OF SUNSHINE.

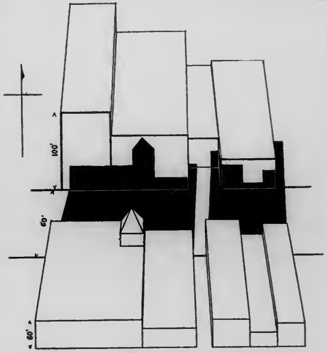
(The figures in the table give the approximate height of building allowable on the side of the street indicated at the top of the column to permit the stipulated amount of sunshine at the curb level on the opposite side of the street. Winter solstice.)

Orientation of Street.

Minutes of Sunshine	South.		—15° W.—		—30° W.—		—45° W.—		—60° W.—		—75° W.—		—West.—	
	Side of Street													
	w.s.	e.s.	w.s.	e.s.	w.s.	e.s.	n.s.	s.s.	n.s.	s.s.	n.s.	s.s.	n.s.	s.s
	Height of Building in Terms of Street Width													
25° North Latitude.														
15	11.1	11.1	10.1	11.8	9.8	12.5	9.3	10.3	4.3	8.4	..	1.0	..	.9
30	5.5	5.5	5.3	5.6	5.0	5.9	4.2	5.6	0.3	3.5	..	1.0	..	.9
45	3.6	3.6	3.4	3.8	3.0	4.4	2.5	3.9	..	2.8	..	1.0	..	.9
60	2.7	2.7	2 6	2.8	2.1	3.1	1.6	3.1	..	2.4	..	1.0	..	.9
75	2.1	2.1	1.9	2.3	1.6	2.5	1.1	2.6	..	2.1	..	1.0	..	.9
90	1.7	1.7	1.5	1.9	1.2	2.1	.7	2.2	..	1.9	..	1.0	..	.9
105	1.4	1.4	1.3	1.6	1.0	1.8	.4	2.0	..	1.8	..	1.0	..	.9
120	1.3	1.3	1.0	1.4	.7	1.6	.2	1.8	..	1.7	..	1.0	..	.9
30° North Latitude.														
15	9.9	9.9	9.7	10.3	9.1	10.9	7.5	8.6	.4	3.1	..	.8	..	.7
30	5.2	5.2	4.8	5.2	4.2	5.3	3.2	4.5	..	2.2	..	.8	..	.7
45	3.2	3.2	3.1	3.5	2.6	3.6	1.8	3.3	..	1.9	..	.8	..	.7
60	2.4	2.4	2.2	2.6	1.8	2.7	1.1	2.6	..	1.7	..	.8	..	.7
75	1.9	1.9	1.8	2.1	1.4	2.2	.7	2.1	..	1.6	..	.8	..	.7
90	1.5	1.5	1.4	1.7	1.0	1.8	.4	1.9	..	1.5	..	.8	..	.7
105	1.3	1.3	1.1	1.4	.8	1.6	.1	1.6	..	1.4	..	.8	..	.7
120	1.1	1.1	.9	1.2	.6	1.4	..	1.5	..	1.3	..	.8	..	.7
35° North Latitude.														
15	8.7	8.7	8.2	8.7	7.6	8.4	4.9	6.6	..	1.8	..	.7	..	.6
30	4.3	4.3	4.1	4.4	3.7	3.8	2.0	3.6	..	1.4	..	.7	..	.6
45	2.8	2.8	2.6	3.0	2.2	2.7	1.1	2.6	..	1.3	..	.7	..	.6
60	2.1	2.1	1.9	2.2	1.5	2.2	.6	2.1	..	1.2	..	.7	..	.6
75	1.6	1.6	1.4	1.8	1.1	1.9	.3	1.8	..	1.1	..	.7	..	.6
90	1.3	1.3	1.1	1.5	.8	1.6	.1	1.6	..	1.1	..	.7	..	.6
105	1.1	1.1	.9	1.3	.5	1.4	..	1.4	..	1.1	..	.7	..	.6
120	.9	.9	.7	1.1	.4	1.2	..	1.2	..	1.0	..	.6	..	.6
40° North Latitude.														
15	7.5	7.5	7.2	7.6	5.7	7.1	3.2	5.0	..	.8	..	.5	..	.5
30	3.7	3.7	3.6	3.7	2.7	3.7	1.3	2.7	..	.8	..	.5	..	.5
45	2.4	2.4	2.3	2.5	1.6	2.5	.6	2.0	..	.8	..	.5	..	.5
60	1.8	1.8	1.8	1.9	1.1	1.9	.3	1.6	..	.8	..	.5	..	.5
75	1.4	1.4	1.2	1.5	.8	1.6	..	1.4	..	.8	..	.5	..	.5
90	1.1	1.1	.9	1.3	.5	1.3	..	1.2	..	.8	..	.5	..	.5
105	.9	.9	.7	1.1	.4	1.2	..	1.1	..	.8	..	.5	..	.5
120	.8	.8	.6	.9	.2	1.0	..	1.0	..	.7	..	.5	..	.5
45° North Latitude.														
15	6.1	6.1	5.6	6.0	4.4	5.1	2.1	3.2	..	.6	..	.4	..	.4
30	3.0	3.0	2.7	3.1	2.0	2.8	.7	1.6	..	.6	..	.4	..	.4
45	2.0	2.0	1.7	2.1	1.2	2.0	..	1.5	..	.6	..	.4	..	.4
60	1.3	1.3	1.2	1.6	.8	1.5	..	1.2	..	.6	..	.4	..	.4
75	1.1	1.1	.9	1.2	.5	1.3	..	1.0	..	.5	..	.4	..	.4
90	.9	.9	.7	1.0	.3	1.1	..	.9	..	.5	..	.4	..	.4
105	.7	.7	.5	.8	.2	.9	..	.9	..	.5	..	.4	..	.4
120	.6	.6	.4	.7	.1	.8	..	.8	..	.5	..	.4	..	.4
50° North Latitude.														
15	4.7	4.7	4.0	4.3	4.0	3.9	.8	1.9	..	.4	..	.3	..	.3
30	2.3	2.3	2.0	2.3	1.7	2.0	.1	1.2	..	.4	..	.3	..	.3
45	1.5	1.5	1.3	1.6	.7	1.4	..	1.0	..	.4	..	.3	..	.3
60	1.1	1.1	.9	1.2	.4	1.3	..	.8	..	.4	..	.3	..	.3
75	.9	.9	.6	1.0	.2	1.0	..	.7	..	.4	..	.3	..	.3
90	.7	.7	.4	.8	.1	.8	..	.7	..	.4	..	.3	..	.3
105	.5	.5	.3	.7	..	.7	..	.6	..	.4	..	.3	..	.3
120	.4	.4	.2	.6	..	.6	..	.6	..	.4	..	.3	..	.3

The undesirability of fronting attached buildings on east-and-west streets can scarcely be over-emphasized. The south side of such streets receives no sunlight whatever during the winter and very little during the summer. On the north side of the street no sunlight is obtained at the curb level except near the ends of the block, where the elevation of the building on the opposite side of the street exceeds the altitude of the sun at noon at that latitude. In other words, where the height is half the width of the street, the pavement on the north side of an east-and-west street at the winter solstice will be in shadow north of 39° 59′ north latitude; where the height is once the street width, north of 21° 33′ north latitude; one and one-half times, north of 10° 14′ north latitude; two times, north of 3° 7′ north latitude; two and one-half times, north of 1° 39′ south latitude; three times, north of 5° south latitude; four times, north of 9° 21′ south latitude; five times, north of 12° 9′ south latitude, and six times, north of 13° 59′ south latitude.

Attached houses should, as a general rule, front on streets oriented north and south. This arrangement not only provides them with the maximum amount of sunlight, but it also secures the most intensive utilization of the land. Such buildings situated on streets oriented at an angle east or west of south, assuming a uniform height limit on both sides of the street, obtain a very uneven amount of sunlight, one side enjoying a superabundance at the expense of the other. No matter what the latitude, the height of building, or the street orientation, one side always receives less sunlight than would be the case on a north-and-south street. With buildings of an excessive height, and particularly at high latitudes, this would not only be true of one side, but of both sides.



SUNSHINE AND SHADOW ON FACADE OF EAST-AND-WEST STREET, WINTER SOLSTICE, 40° NORTH LATITUDE, 11.30 A. M.

To limit the height of buildings differently on the two sides of the street in proportion to the sunlight coefficient of each side would result in entirely different types of development on the two opposite sides of the street. To apply the sunlight coefficient, on the other hand, to the street width so that buildings of the same height could be erected on either side of the street and each side enjoy its minimum standard of sunlight would have the result in many instances of giving the street an absurd width. Either of these expedients is obviously not so satisfactory as a north-and-south orientation of streets with a uniform building height on both sides of the street.

There must be economy in the utilization of land as well as in sunlight. Where there is a conflict between the two there is little doubt as to the side the owner of land ripe for urban development will champion. Fortunately, in this case the interests of the owners harmonize with those of sunlight planning. A north-and-south orientation of streets for this type of building not only results in the fullest utilization of land, but it also secures the best distribution of sunlight. Blocks improved with houses in rows or with apartment houses, then, should have their length parallel to north-and-south streets and their breadth parallel to east-and-west streets. In such developments the distance separating east-and-west streets is of no particular consequence to the sunlight of apartments. The location of such streets in these sections of the city may, therefore, be left entirely to considerations affecting the convenience of traffic. Blocks the length of which parallels east-and-west streets should be re-subdivided into lots fronting on minor north-and-south streets laid out across the narrow dimension of the block before they are improved with attached houses.

The amount of sunlight obtained on east-and-west streets in private-house districts may be effectively increased by staggering the buildings in such a manner that no house is directly back of one in front on the same block.

Arrangement of Windows

All windows oriented in a certain manner, obviously, do not receive sunshine for the same time. Even tho there be no buildings on the opposite side of the street, a considerable per cent of the sunshine received by the façade will usually be cut off from entering buildings by the thickness of the wall in which the windows are set.

Barring obstructions, it is the size of a window with reference to the thickness of its enclosing wall which limits the period of sunshine admitted to a room. A small window in a thick wall admits sunshine for a time proportionately less than a large window in a thick wall. For an unobstructed window of a given size, the sunshine period diminishes with the thickness of the wall; for a given thickness of wall, it increases with the height and width of the window.

The sunshine period cut off by walls of a given thickness at a window opening, as shown by Table I, is very much greater in a northern than in a southern city.

The volume of sunshine received in rooms is of just as much importance as the sunshine period. A room, for instance, may enjoy direct sunshine for a considerable period and yet have a comparatively small portion of its cubic contents acted upon by direct rays from the sun.

The volume of direct sunshine entering a window decreases far more rapidly with increased height of buildings than does the sunshine period, and this difference increases with added height of buildings. Where opposite buildings obstructing the window are low, the ratio of the sunshine volume to the sunshine period is nearly as great for a thick wall as for a thin wall. But this ratio is considerably reduced in the case of high opposite buildings.

Windows opening to the south admit at some latitudes the entire sunshine period enjoyed by the building façade, provided the walls are not too thick. But this is an exceptional condition. The general rule is that the walls in which windows are set shut out sunshine for a less time on north-and-south streets than is the case on streets of any other orientation.

Various expedients may be tried to increase the sunshine volume entering rooms. By a beveling of the window opening, a window set in a thick wall can, within limits, be made to admit as much sunshine as one set in a thinner wall. The position of windows within rooms is also of importance. Thus a window the top of which is situated near the ceiling permits a deeper penetration of the sun rays into a room than one the top of which is placed some distance below the ceiling. The sunshine volume in rooms with windows opening to either the east or the west may be considerably increased by having the windows located as near as possible to the south wall of the room. Windows opening to the south should be placed as near the middle of the front wall of the room as practicable.

Front and Rear Building Lines

Every attached house should preferably not only front on a north-and-south street, but should also back on a rear yard running parallel to such a street. This yard should be open at either end so that each building backing on it may derive full benefit of the sunlight purchased by its vacant space. Uniform building lines are highly desirable both in front and in rear. They not only conserve the supply of sunlight, but they also economize space. Buildings "pocketed" at either end between deeper buildings receive much less sunlight than those conforming to a common building line, unless they are equipped with a side yard of sufficient width on the south to insure their own sunlight. The provision of such a side yard is usually so expensive a proceeding that it can be afforded only in private home districts.

Inner and Outer Courts

Deep buildings in solid blocks are quite generally a misfit in a sunlight plan. They necessitate inner and outer courts and open spaces, the economic use of which does not ordinarily conform to the height standards of sunlight. Inner courts should not be used at all; outer courts, except those opening to the south, should be used very sparingly. The justifiable use of outer courts depends almost entirely upon the direction of their open end. Outer courts opening either to the east or to the west are subject to the same criticism as east-and-west streets—one side receives no sunlight at all on the shortest day in the year. Outer courts opening to the north are still worse; unless they are extremely long, only a triangular segment of either side wall near the top of the building receives any sunlight. These objections, however, do not apply to an outer court opening to the south, either side of which possesses the advantages enjoyed by buildings on north-and-south streets, while the end, if the court is not too long, has many of the advantages of a building on the north side of an east-and-west street. An inner court possesses none of the advantages of an outer court open to the south, while it has all the disadvantages of courts open toward the east, west and north in an exaggerated way. Buildings on the south side of east-and-west streets should have their outer courts opening into the rear yard, those on the north side into the street.*

The type of building which most readily avoids the use of courts is one facing on a north-and-south street not more than two rooms deep measured from east to west, every room deriving its sunlight directly either from the street or the rear yard in the case of attached houses or from the side yards in addition to the southerly exposure in the case of detached houses. Such buildings enjoy the maximum possible sunlight.

The Lot Unit

The size of the lot unit is, of course, always conditioned by the character of the building and the amount of space demanded for lawns, gardens and accessory buildings. For sunlight purposes it should also be conditioned by its latitude and its orientation. The minimum practicable depth of workmen's dwellings of low cost and built in rows is probably about 25 feet. How deep at different latitudes would the lot unit have to be for such buildings oriented on north-and-south streets with a yard in the rear, to obtain at least two hours' sunlight on either side at the street and yard level, assuming the height to be 25 feet and ignoring any demand for extra space on account of gardens and accessory buildings?

The width of the yard on each lot provided in the rear of the houses at each of these latitudes respectively would be equal to half the street width in front. Utilizing our sunlight coefficients in Table III, we find the required street width at each latitude to be as follows: 19.2 feet at 25° latitude, 23.4 feet at 30° latitude, 27.2 feet at 35° latitude, 32.4 feet at 40° latitude, 41 feet at 45° latitude, and 64.1 feet at 50° latitude. The minimum depth allowable for the lot unit under these limitations would be 34.6 feet at 25° latitude, 36.7 feet at 30° latitude, 38.6 feet at 35° latitude, 41.2 feet at 40° latitude, 45.5 feet at 45° latitude, and 57.1 feet at 50° latitude.

The depth of lot and width of streets required for any type of development with a minimum sunlight standard can easily be ascertained by using the proper sunlight coefficient. A sunlight plan does not concern itself with the width of lots except where side yards are utilized to obtain sunlight. The width of such yards and the height of the adjacent buildings must, of course, stand in the same relation as their sunlight coefficients.

Setbacks and Cornices

Setbacks to maintain the minimum standard of sunlight at the curb level must be in the same ratio as their sunlight coefficients. If not, they are to be considered as an increased height of building, the amount of such increase depending upon the setback angle. Cornices usually diminish the effective street width by at least as much as, and often by considerably more than, the amount of their projection, when the height of building is measured to the cornice.

Conclusions

Good housing means sunshine, daylight, air, ventilation. These are the avowed objects of all building codes. The height of buildings has been restricted, the percentage of lot that may be covered by buildings limited, and the size of courts and yards rigidly regulated—all with the hope that the aggregate amount of sunshine, daylight, air and ventilation in the community might be increased. This hope has, of course, in a measure been realized; for some control is better than no control, even tho that control may be based upon a very imperfect appreciation of the means necessary for the achievement of these ends. But what is needed for the promotion of good housing to-day quite as much as restrictive regulations is the definition of scientific standards which will directly relate height and area provisions to the minimum requirements of public health. Without the establishment of such standards, we cannot be sure that our building codes encourage the right kind of development.

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* The writers have worked out two complete sets of tables, one showing the exact period of sunshine and the other the daylight illumination enjoyed by inner and outer courts under all kinds of general conditions.

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